REMARKS

In the Claims:

Claims 8-19 are currently pending.

CLAIMS REJECTED UNDER 35 U.S.C. § 103(a)

The Examiner has rejected Claims 8-19 under 35 U.S.C. § 103(a) as being unpatentable over Kovacs (DE 3335962) in view of Takada et al. (JP 61-39416). Applicants respectfully traverse this rejection.

Examiner contends that Kovacs proposes to use a four-cycle engine for a chain saw, Takada discloses a lubrication apparatus, and one of ordinary skill in the art would combine the engine lubrication of Takada with the tool of Kovacs. However, the Examiner has not identified any motivation in Kovacs or Takada for combining these references and then miniaturizing them; has not shown any evidence or suggestion that the miniaturization of Kovacs combined with Takada would result in an operable, handheld, portable power tool; and has not shown how the references could be combined without drastically altering what the references disclose.

Neither Kovacs nor Takada suggest their combination or miniaturization. The Examiner's purported reasoning that miniaturization was not done prior to Applicants' invention because of expense, and not technology, is not supported. There is no showing that the mere miniaturization of either the partial engine of Kovacs or the lubrication system of Takada will necessarily result in a properly working engine for use on a portable, handheld power tool. Without a showing that mere miniaturization would accomplish that which is taught in Claims 8-19 the Examiner's contention simply amounts to speculation. In re Fritch, 972 F.2d 1260, 1265-66 (Fed. Cir. 1992) (stating that the mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious to one skilled in the art unless the prior art suggested the desirability of the modification). There is no teaching as to how the partial four-cycle engine taught in Kovacs or Takada can be miniaturized to provide a reduction in weight and size in order to be used with a hand-held tool. To the contrary, the scientific community recognized that miniaturization alone would not

accomplish what Applicants invented. For example, the 1993 Popular Science article titled *The Little Engine That Could* (attached hereto as Ex. A) states that to characterize Ryobi's four-cycle engine as "just miniaturizing" is "an understatement of the cleverness of the Ryobi engine design." (Ex. A, p. 92).[1] The Examiner's contention that simply miniaturizing the partial four-cycle engine of Kovacs and combining it with the lubrication apparatus of Takada would have been obvious to one skilled in the art is inapposite in view of the findings of this article. The Examiner has not provided a reference to indicate a teaching or motivation that combining Takada and Kovacs would be obvious to one skilled in the art. Further, there is nothing in either Kovacs or Takada that suggests miniaturization of the Takada lubrication system. Such a combination and the further miniaturization of that combination is mere speculation that is made with the benefit of hindsight only, which is improper. In re Fitch, 972 F.2d at 1266 (stating that it is impermissible to use the claimed invention as a template to piece together a teaching from the prior art so that the claimed invention is rendered obvious).

The Examiner also contends that one of ordinary skill in the art would be motivated to combine the lubrication system of Takada with the 4-cycle engine of Kovacs in order to obtain the advantages of Takada. On the contrary, Applicants submit that one of ordinary skill in the art would not be motivated to combine Kovacs and Takada because the combination would result in something that eliminates the required features of one or both of the references. Specifically, Kovacs discloses certain important engine features that are drastically different from those in Takada. For example, Kovacs requires that "the engine is built with an inlet and outlet *in the cylinder head*" (Kovacs, p. 2). Further, Kovacs requires two inlet openings (Kovacs, p. 2), the second being in the cylinder center (Kovacs, p. 2). By comparison, Takada requires that the inlet and outlet valves as well as the mechanism for operating the valves be "provided above the cylinder head" (Takada, p. 2). The structures of Kovacs and Takada do not appear to be compatible and any combination of the two would significantly alter the structure disclosed by each of those references. There can be no

[1] This article refers to Ryobi because the parent application was originally assigned to Ryobi. Ryobi has since transferred all of its rights to MTD.

motivation in a situation such as this. In re Fitch, 972 F.2d at 1265 n. 12 (stating that a proposed modification is inappropriate for an obviousness rejection if the modification would render the prior art reference inoperable for its intended purpose); In re Gordon, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

Further, there is no teaching in Takada as to how the disclosed lubrication system is capable of being adapted to be incorporated into different engines, let alone the partial engine disclosed in Kovacs. Without further teaching, it would not be obvious to one skilled in the art to combine the lubrication apparatus of Takada with the four-cycle engine of Kovacs. Therefore, Applicants submit that Claims 8-19 are patentable over the prior art, and that the present apparatus is not an obvious combination of Takada and Kovacs.

In view of the foregoing comments, Applicants respectfully submit that Claims 8-19 are patentable over Kovacs in view of Takada et al., and the claims are in a condition ready for allowance. In the event issues remain that the Examiner feels might be resolved by interview, he is respectfully requested to telephone applicant's attorney at (312) 321-4221.

Respectfully submitted,

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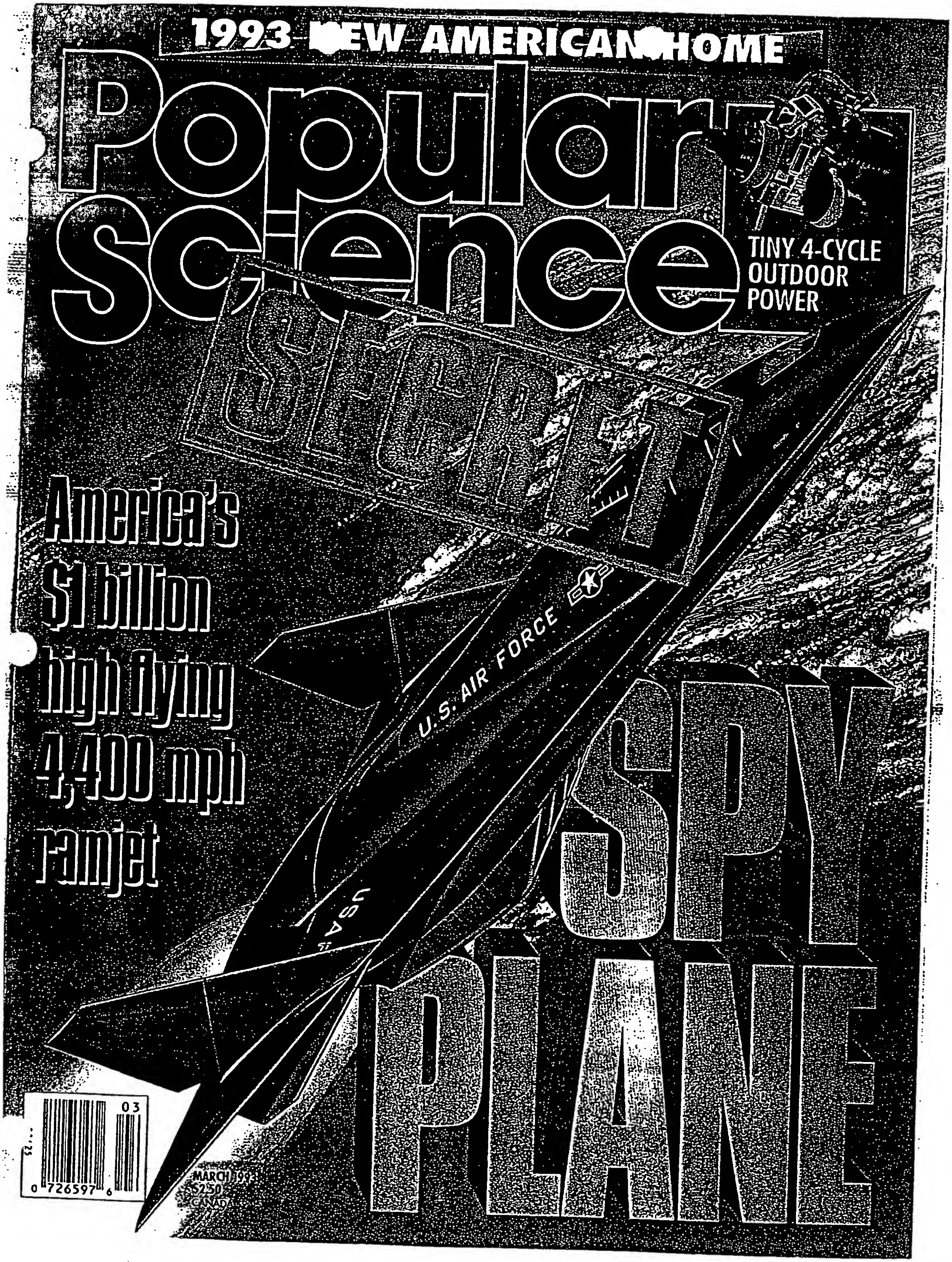
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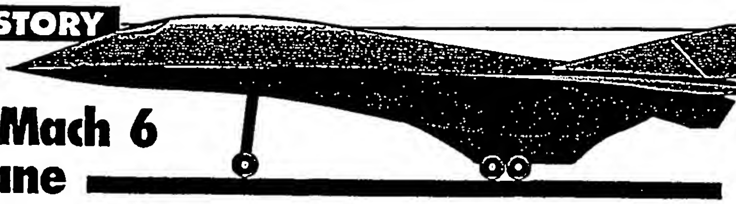
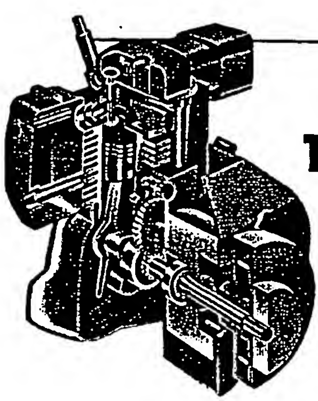
COVER STORY





COVER ILLUSTRATION BY KERRY LESLIE

THE LITTLE ENGINE THAT COULD

This four-cycle engine is lightweight enough for hand-held equipment—and clean enough for California.

BY JUDITH ANNE GUNTHER

Here, claimed experts in the outdoor power-tool industry, was a problem without a ready solution: How could they build a gas-powered engine small and powerful enough for consumers, yet sufficiently clean-burning to meet increasingly demanding legislation?

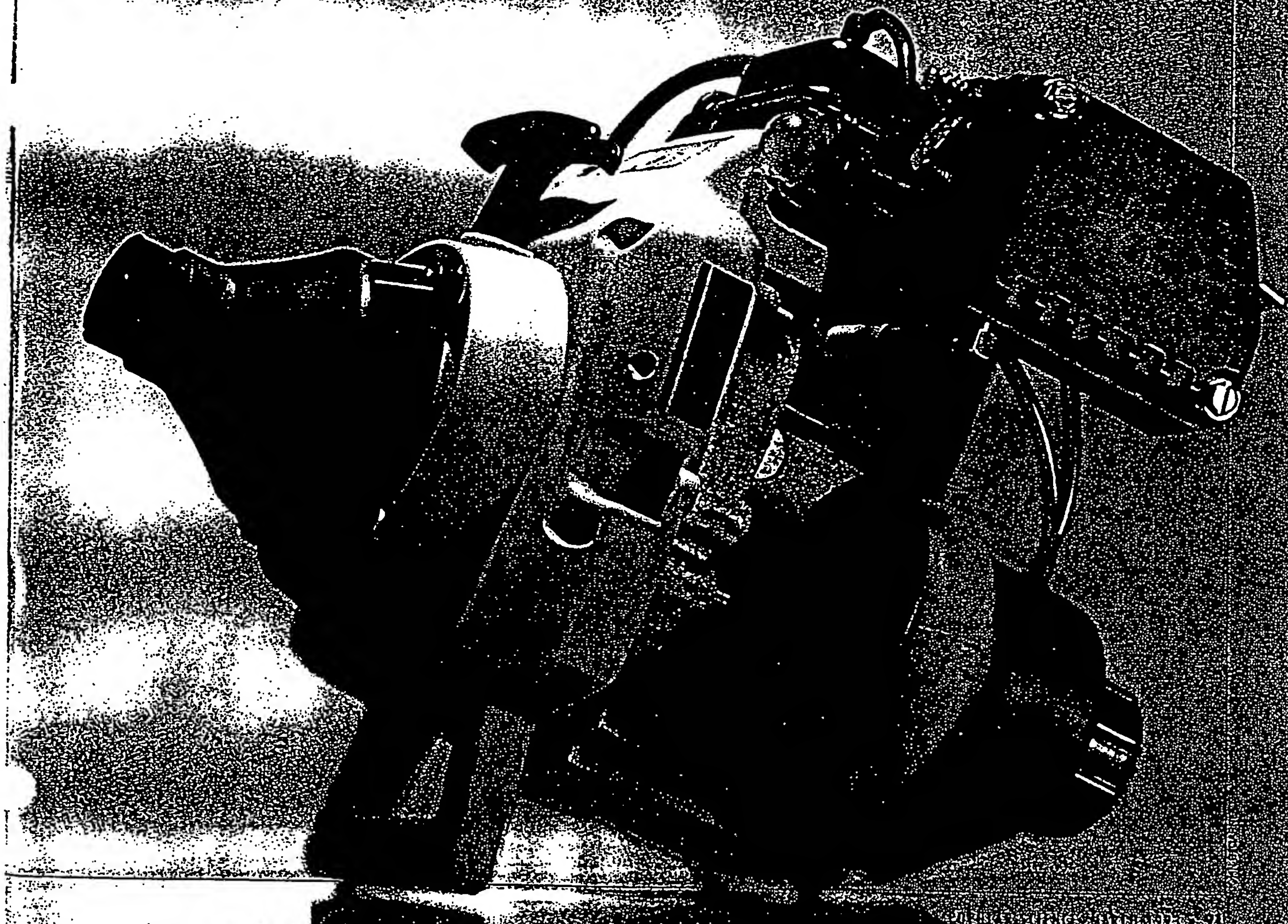
Now one manufacturer, Ryobi North America, the South Carolina-based subsidiary of the Japanese toolmaker, says it has an answer. Ryobi's CleanAir engine is a radically scaled-down 26cc four-cycle engine that deftly delivers one horsepower in an eight-pound package. And Ryobi is betting that this engine will heavily influence the hand-held outdoor power tools that consumers buy in the mid-1990s.

For decades, manufacturers have relied on two-cycle engines to power chain saws, trimmers, blowers, and other tools that require light weight and brute force, taking advantage of a power pulse with every crankshaft revolution ["Greener Pastures," July '92]. But such performance has its price—air pollution—and in 1990 the California Air Resources Board (CARB) established stringent emissions standards that will have to be met by all gas-powered utility products sold in that state. The CARB regulations, which take effect in two phases, 1994 and then 1999, have been criticized by some manufacturers as being too difficult to meet in a relatively short period of time. (Discussions are under way between CARB and manufacturers to move the first-phase deadline back by one year.)

How did Ryobi get the jump on the industry? Partly by making the project a priority item as early as 1989, and partly by pushing the limits of small-engine technology. The CleanAir engine circumvents the exhaust-emissions problem inherent in a two-cycle engine mainly by employing its cousin, the four-cycle engine.

The project had sprung from a concept for a small-displacement, low-cost, four-stroke engine that had been proposed to Ryobi in 1988 by Robert Everts, an Arizona-based engineer whose company produced the first working prototype. Commonly used in heavier lawn and garden equipment, a four-cycle engine fires its ignition on every other revolution and uses conventional poppet valves to control the flow of the incoming fuel-air mixture and outgoing exhaust; this helps reduce the chance that some fuel will escape unburned. And unlike many two-cycle engine designs, the four-cycle doesn't require that the lubricating oil be mixed directly with the gasoline, a major cause of the blue-smoke plume that routinely spits out of two-cycles.

"We started out with three criteria for this engine:



says Ryobi senior vice president William McLay. "First, it had to meet California's emissions standards. Second, it could not be any heavier than current two-cycle engines. Third, it couldn't cost significantly more than high-end engines. And we feel that the CleanAir engine meets these parameters."

In theory, building a small four-cycle engine might not seem difficult, but in reality Ryobi faced numerous design and manufacturing hurdles. Today's small four-cycle engines normally weigh 40 pounds and generate about 3.5 horsepower. The CleanAir engine, in comparison, weighs just eight pounds and generates one horsepower. Such dramatic downsizing required smaller components; some parts, such as the valves, didn't exist and had to be designed and manufactured specifically for this engine.

Still, industry experts are cautious when discussing the engine. "There's no magic here," remarks Glenn Keller of the Engine Manufacturers Association in Chicago. While he acknowledges the difficulties in design, he sums that "Ryobi has just miniaturized everything."

A logical analysis in the broad sense, but, as additional research indicates, something of an underestimate of the cleverness of the Ryobi engine design. Such a simplistic engine-shrinking could certainly have produced the low emissions levels and perhaps the necessary power output, but doubtfully could have done it at a competitive manufacturing cost. Here the CleanAir engine demonstrates some unique design solutions that give it a clear edge, at least for the time being.

"We are aware—at least it's rumored in the industry—that other manufacturers have made small four-cycle engines," McLay says. "But they're either polluting or very costly or too heavy." Likewise, tiny four-cycle engines used in another application—model airplanes—don't fit the bill for running trimmers and blowers. "That's a whole different power class," says McLay.

To operate a grass trimmer, he explains, a small four-cycle engine must turn at about 7,000 or 8,000 rpm—twice the speed of a mower-type engine. Increasing speed means increased heat, and possibly increased wear on engine parts. Although McLay won't reveal the metallurgy processes that were employed ("We hope it will take a while for our competitors to figure it out," he says), he does allude to alloys, heat-treating methods, and materials chosen for their lubricity.

To keep engine temperatures down, Ryobi engineers worked out an unusual two-piece cylinder head consisting of a lower casting that houses the combustion chamber and an upper section that encloses the rocker arms used to open the valves. This design permits cooling fins to be placed strategically next to some of the hottest areas of the engine—the exhaust valve and bridge area between the valves.

For all of the development effort Ryobi invested in it, the CleanAir engine must still be competitive with other products if it is to sell in the 49 states that *don't* have emissions regulations yet. (The EPA is reviewing emissions data of so-called utility engines; nationwide regulations may be announced by the end of 1993.)

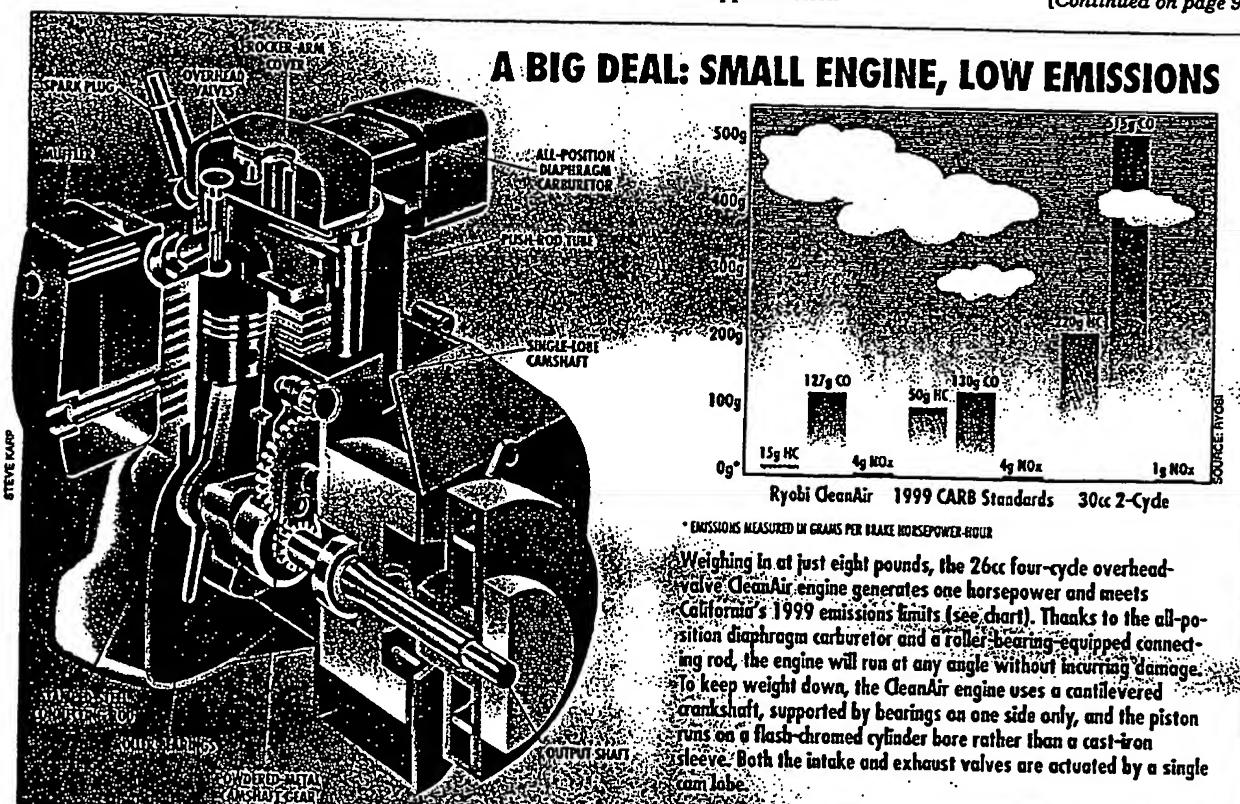
"Only certain people will buy a product because it is environmentally friendly," McLay acknowledges. Performance, he maintains, will be a major selling point.

The most significant benefit consumers will find is the more consistent power produced by four-strokes. "The characteristic of a two-cycle engine is that it has to be very high on the rpm curve to get the most torque output," he explains. "But a four-cycle has a flatter curve, so when the engine is working hard, it still produces the torque. As rpm drops, torque doesn't drop much at all."

Another plus inherent in a four-cycle engine is that it doesn't require a gas-oil mixture. Instead, lubricant is distributed by a dipper at the end of the connecting rod—the conventional

(Continued on page 96)

A BIG DEAL: SMALL ENGINE, LOW EMISSIONS



Weighing in at just eight pounds, the 26cc four-cycle overhead-valve CleanAir engine generates one horsepower and meets California's 1999 emissions limits (see chart). Thanks to the all-position diaphragm carburetor and a roller-bearing-equipped connecting rod, the engine will run at any angle without incurring damage. To keep weight down, the CleanAir engine uses a cantilevered crankshaft, supported by bearings on one side only, and the piston runs on a flash-chromed cylinder bore rather than a cast-iron sleeve. Both the intake and exhaust valves are actuated by a single cam lobe.

The little engine that could

[*Continued from page 92*]

splash-type system used in small four-cycles—which Ryobi claims will be effective even with the engine running inverted. By itself, it would seem unlikely that the dipper system could possibly live up to that assertion. That is, until you learn that both ends of the connecting rod ride on caged roller bearings (rather than conventional insert shells), which get along fine on very small amounts of oil. As a side benefit, the weight, cost, and power drain of an oil-circulating pump have been eliminated.

The caged roller bearings are fitted into a steel connecting rod that is built up from two separate stampings, rather than the usual casting or forging. The stamped parts are left and right sections; there is no separate bearing cap at the bottom end. This construction technique requires that the crankshaft be pressed together from individual pieces for ease of assembly, and here again Ryobi breaks from tradition by using a stamped counterweight section mated to a simple steel output shaft. Additionally, overall engine weight is kept low by the crankshaft's cantilevered design; the engine is supported in ball bearings only on the flywheel side, ending abruptly at the connecting rod.

The enlightened engineering doesn't end there, either. To eliminate a heavy iron cylinder sleeve, the CleanAir engine is built with a long-lasting, flash-chromed aluminum cylinder bore. The valve train operates from one cam lobe, using an ingenious follower mechanism that simultaneously converts the cam's rotation to the required reciprocating motion and also turns the action 90 degrees to line up with the ball-pivot rocker arms.

In addition to exhaust emissions, Ryobi addressed another form of pollution: noise. While the CleanAir engine's noise level is only a few decibels less than most engines, the biggest difference is its deeper pitch. "The improvement is the quality of the sound," says McLay. "High-pitched sounds and lower-pitched sounds at the same decibel level are two different experiences to the human ear."

Computer-aided-design technology played a major role in this process. "We incorporated a large-volume muffler, but what's more, we used computer-aided design to create noise-canceling baffling," he says. To reduce the noise generated by the gear drive, engineers designed gear profiles that would operate more quietly and then manufactured the gears in a powdered-metal material that provides some advantage in sound damping.

Now engineers are ironing out the last details, including smoothing the engine's vibrations. "We're still fine-tuning that," says McLay. "Four-cycle engines tend to vibrate more than two-cycles because they fire every other stroke."

A 1994 debut

The CleanAir engine will be manufactured almost entirely in Arizona and will first appear in a hand-held grass trimmer at the industry's exposition this summer in Louisville, Ky. Consumers can expect to see that product on store shelves in the first part of 1994. Meanwhile, McLay says Ryobi will consider applying the technology to other outdoor power tool products, such as brush cutters, cultivators, and leaf blowers, as well as licensing the engine to manufacturers of water pumps, mowers, and high-power washers. PS